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(51) INT CL$^6$
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(52) UK CL (Edition O )
**B2H H7**

(56) Documents Cited
**US 4834887 A US 4265741 A US 3901799 A**

(58) Field of Search
UK CL (Edition O ) **B2H H14 H7**
INT CL$^6$ **B04C 3/00 , B07B 4/00 4/02 7/08**
**ONLINE DATABASES: WPI,CLAIMS,EDOC,WPIL**

# (54) DRY SOLIDS/SOLIDS SEPARATION PROCESS

(57) Apparatus for the dry separation of two solids due to differences in relative density comprises a separating device of the type incuding a rising gas flow and cyclonic movement in which the apparatus comprises a stepped spiral wall incorporating negative vertical angles, an inclined inlet and a ridged spiral and convex bottom internal section which will allow for the separation of one solid from another depending on the differing size and/or densities of the solids.

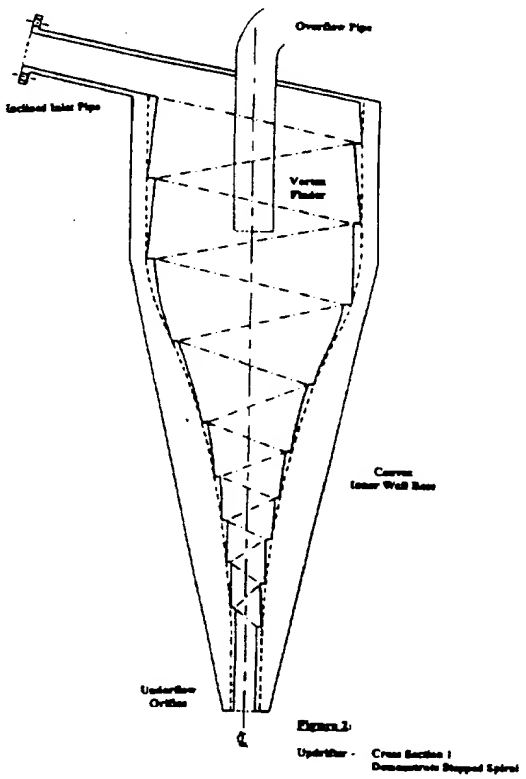


Figure 1:
Upshifter - Cross Section I Demonstrates Stepped Spiral

GB 2 309 182 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

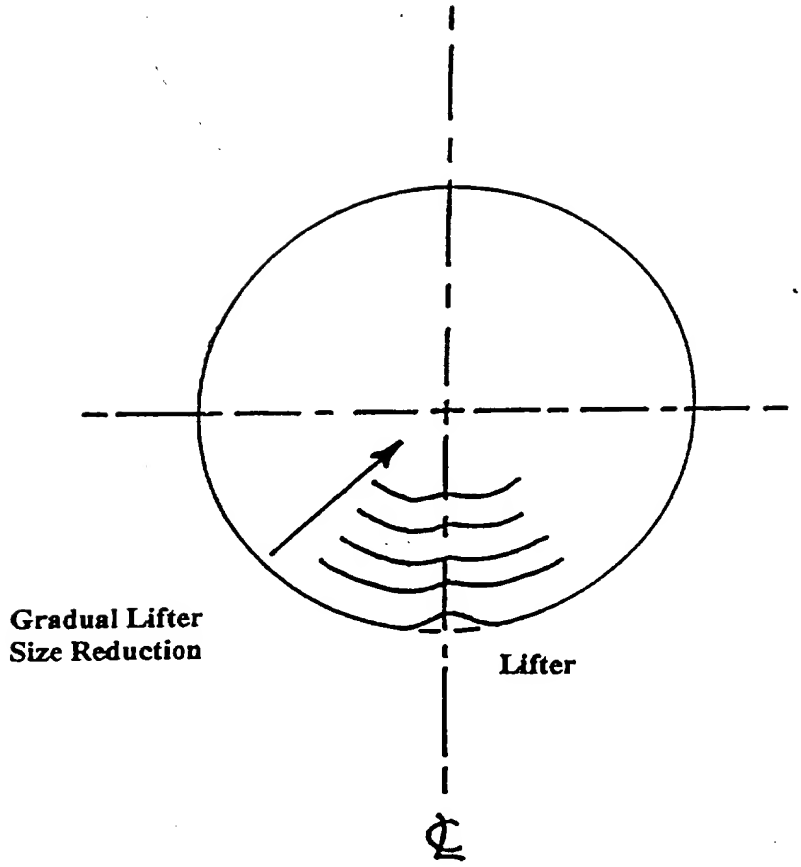


**Figure 1:**

**Drawing To Show The Lifter**

NOT TO SCALE

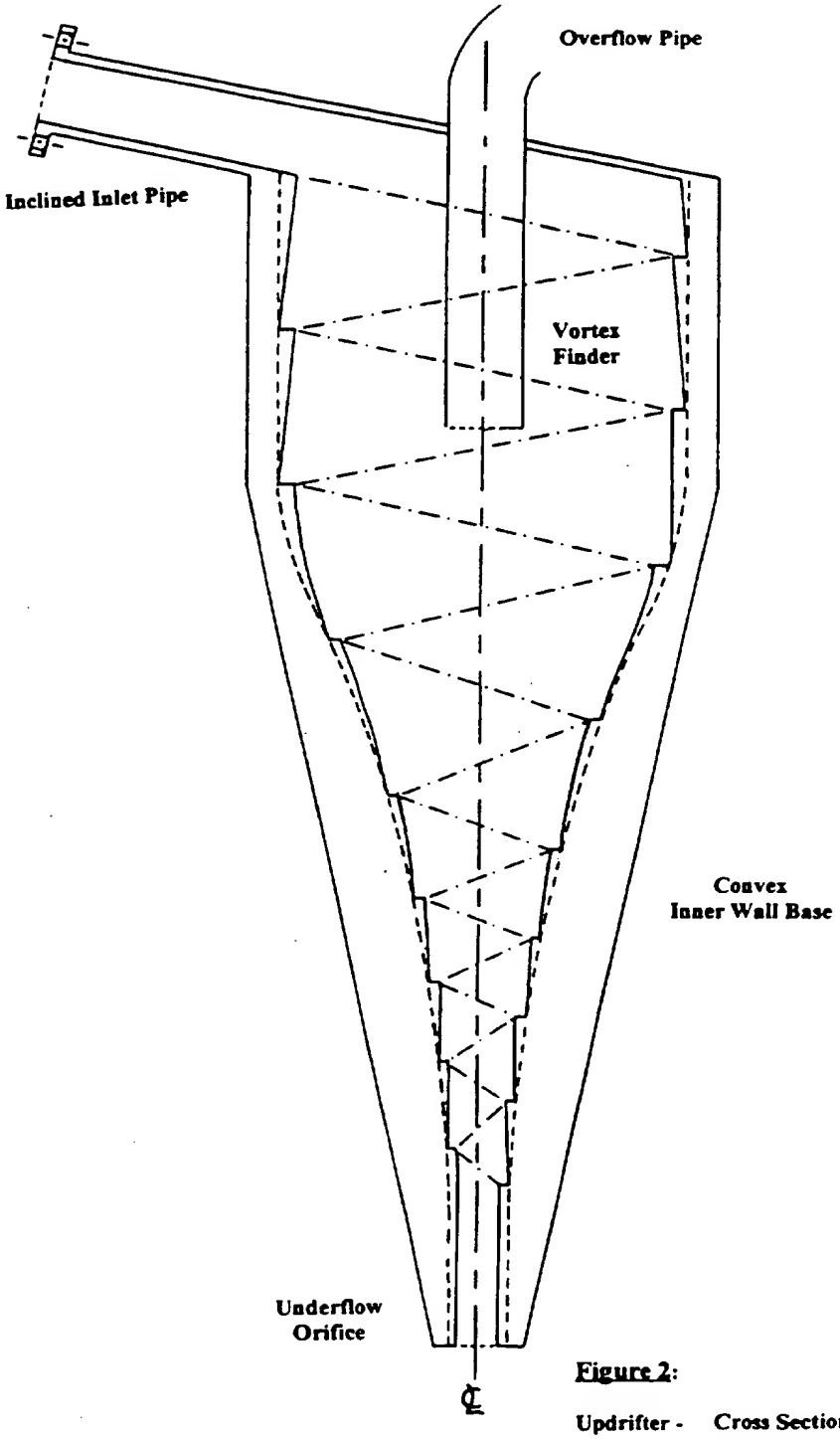


**Figure 2:**

**Updrifter - Cross Section 1**
**Demonstrate Stepped Spiral**

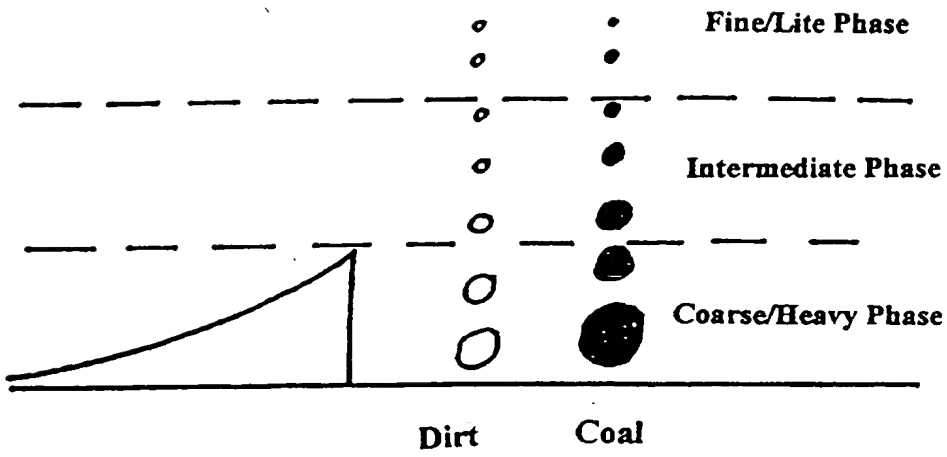


**Figure 3:**

**NOT TO SCALE**

**Diagram To Show Lifter Material Arc**

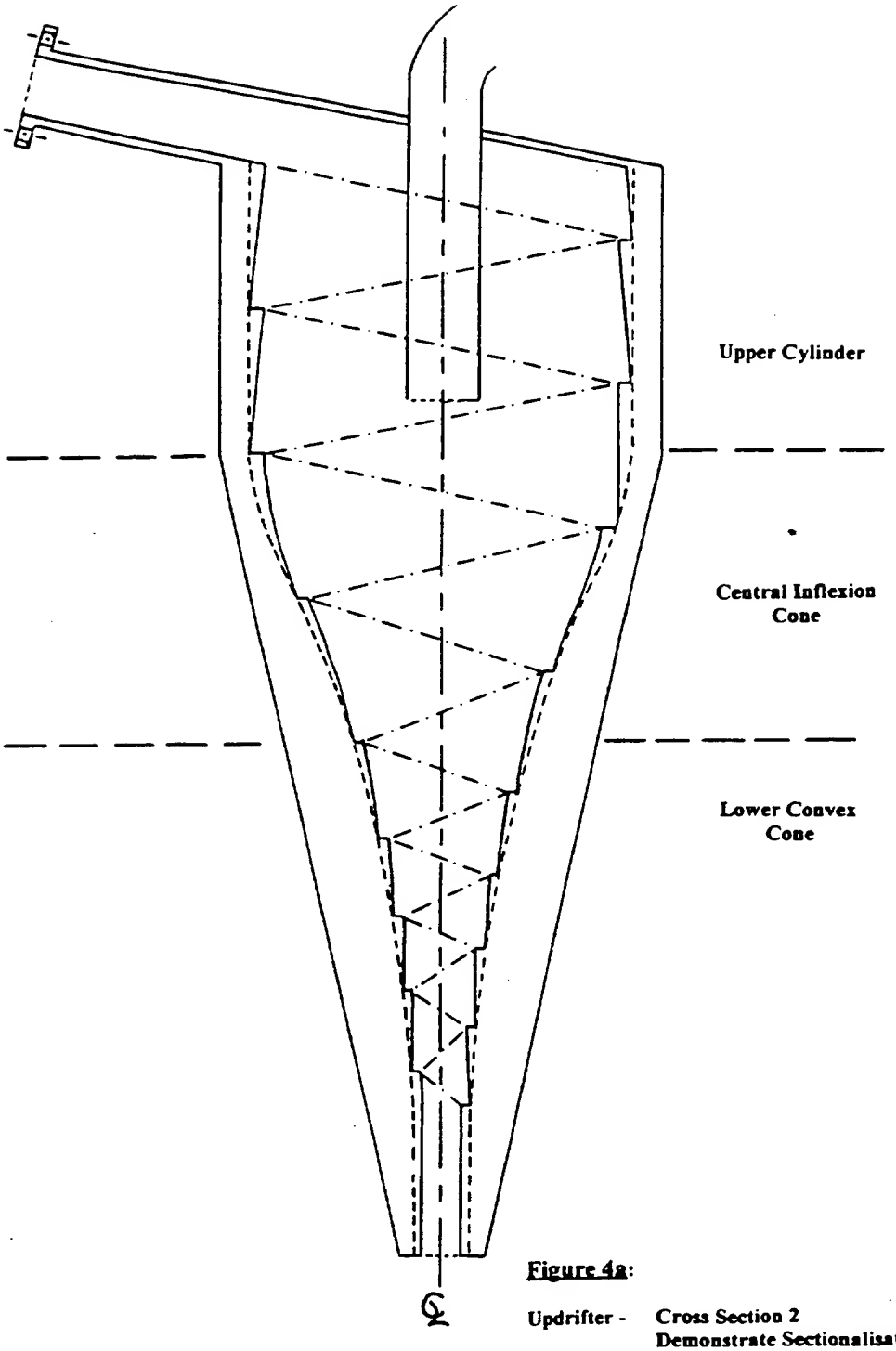


**Figure 4a:**

**Updrifter - Cross Section 2**
**Demonstrate Sectionalisation**

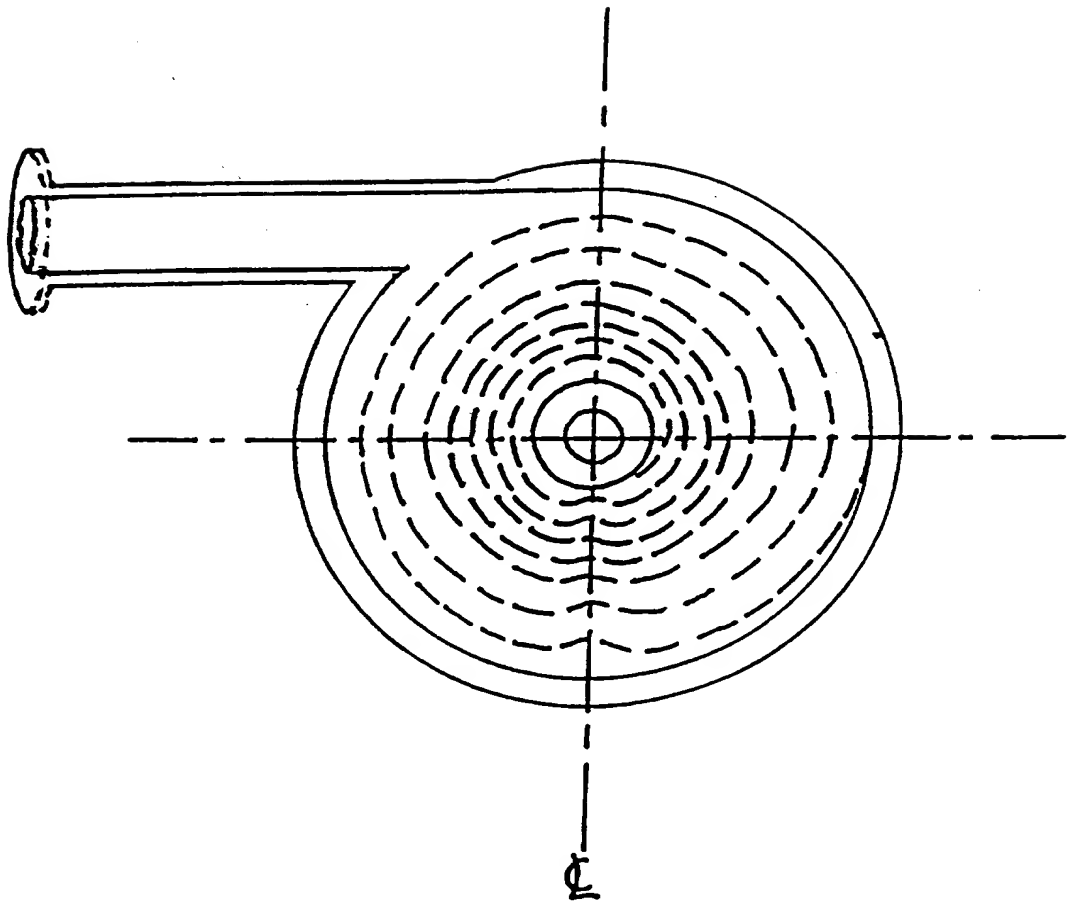

**Figure 4b:**

NOT TO SCALE

**Updrifter - Basic Plan View**

## Description

The Updrifter concept utilises the centrifugal principal, with a unique inner wall design giving the mechanics to effect a separation. The Updrifter offers a high throughput, continuous process and large potential for efficient cleaning of the two solids.

The inner wall design allows the segregation of dirt from coal particles due to the greater centrifugal forces acting on the dirt element. The ability to exploit this fact in a dry system being created from inducement of the mechanics of jigging. Not a jigging instigated from a system secondary flow perpendicular to the main flow direction i.e. a Washbox, but by an alteration to the wall curvature to provide a lift to the bed on each full rotation of material. See Figure 1.

With a difference in relative density between required particle separation of approximately 400/500 kg/m$^3$ for middlings to dirt and close to 1,000 kg/m$^3$ for clean coal to dirt. It will be possible to establish a bed cross section with progressively higher dirt content as you travel towards the outer wall.

Due to the removal of a medium offering stability to the vertical movement of particles through the Updrifter and with the obvious requirement to achieve an optimum residence time. A design must offer the facility to control:

a) the vertical flow of material and

b) allow for minimising turbulence effects on the stream as it is presented into the Updrifter.

For the first reason the cylinder walls will be of step type, with negative angles on the initial steps. This will give the ability to control the vertical flow of material through the Updrifter and ensure no cross bed contamination occurs, thus negating the efficiency of the jigging. See Figure 2. For general cross section.

The stepped walls will progressively take to the shape of the base cone section allowing for:

a) the negative turbulence effects to be reduced as the cone narrows out, thus ensuring a uniform central vortex,

b) the bed to be evenly distributed across each ledge during the area of liberation.

The height of each step will progressively reduce down through the initial stages of the base convex cone section. Ensuring that the increase in angle of spiral is only marginal, thus stabilising the rate of vertical descent of material through this part of the unit. It will also ensure that the bed depth of material is relatively constant through out the initial stages of liberation, as more material is extracted to overflow.

To ensure this continual reduction in step height doesn't reach the point in the lower cone section, where the reduction in height overcompensates for the removal of a layer of material. Thus, giving the opportunity for the high density material to report to the overflow; and for this increase in bed depth to cause blocking of the underflow spigot and hence further inefficiencies. The step heights will increase again, negating any possible efficiency problems and in turn will effect a further increase in the magnitude of vertical flow of material. See Figure 2.

From inducing the rate of vertical flow through the Updrifter at its entrance, there will be minimal thickening of the bed through out. Giving consistency of rejects and removing the potential for further turbulence. See Figure 2.

By altering the inlet from a straight line to an angled type, guidance for the feeds vertical flow will be provided/suggested; thus solving the problem of entrance turbulence. This method allows the creation of preferred flow lines, rather than allowing them to form of their own accord.

From using an inlet that promotes the required flow lines a degree of turbulence is removed from the system, reducing any unnecessary pressure drop or impairment of cleaning efficiency. This reduction in turbulence being ever important as the size fraction being treated reduces; and allowing for minimisation of any negative segregation effects.

The physical removal of the upper clean coal from the lower dirt section of the bed will be achieved by utilising a convex base section. With this design and the use of the lifting element, different layers of the newly formed bed will be guided towards the vortex and the overflow. The lifter will reduce in severity as the spiral progresses down the Updrifter. This is due to the fact that initial bed segregation will require a more severe jigging effect. As the material moves through the unit, finer bed layer cuts are required with minimal disturbance of the overall bed layering.

The upper body cylinder will be optimised to effect the segregation of the bed, with the lower cone being geared towards liberation of product (or reject dependent on ROM coal characteristics) to overflow.

The extraction principal is based on the arc or route the different density particles will take to return to their flow around the outer wall; and the potential on this arc of the particles being caught in the upward current of the vortex. Using a convex walled cone as shown there will be a breakdown of particles through the material arc. See Figure 3. As the wall converges towards the vortex, a different section of the bed will be removed. Effectively slicing off material with different relative densities.

The construction of the Updrifter is sectionalised into three compartments, see Figure 4a:

1) Upper Cylinder
2) Central Inflexion Cone
3) Lower Convex Cone

For processing of specific size ranges and different materials, a set diameter of Updrifter will be recommended. See Figure 4b for plan view. Then dependent on whether the bed needs a long upper cylinder section or a short one to establish the layered bed; or if the key extraction zone based on two solids of near gravity material is in the lower convex cone, requiring a short inflexion section and a long lower cone The sections will have a range of sizes available and will be easily interchangeable.

To minimise any points of high friction, creating bed disturbance, the break points should be on the leading edge of the steps. This should ensure no frictional forces are present that could induce inner bed movemnet, thus impeding efficiency. A screw thread will be utilised for joining sections together. In addition to the screw feed it is recommended that an external clamp is used to uniformly compress the entire unit ensuring that it is sealed sufficiently so as not to impede efficiency.

Although, this piece of equipment has been explained and detailed on the basis of fines/smalls cleaning. The concept will, based on certain scaling factors, allow for effective processing of larger sized feed material.

Another additional application, dependent on the material to be treated, would be to use the Updrifter design in a water based medium circuit for the purpose of processing.

## Drawings:


Figure 1: Drawing To Show The Lifter . . . . . 1

Figure 2: Updrifter - Cross Section 1 To Demonstrate Stepped Spiral . . . . . 2

Figure 3: Diagram To Show Lifter Material Arc . . . . . 3

Figure 4a: Updrifter - Cross Section 2 To Demonstrate Sectionalisation . . . . . 4

Figure 4b: Updrifter - Basic Plan View . . . . . 5

## Claims:

1. The Updrifter with stepped spiral wall incorporating negative vertical angles, inclined inlet, ridged spiral and convex bottom internal section will allow for the liberation of one solid from another, where the two have different relative densities and/or reside in different size fractions.

2. An Updrifter as described in Claim 1 will allow for an increase in sulphur removal from the fines element of the industrial and power generation products, when the unit is applied to treating coal fines. The liberation of pyritic sulphur only will be achieved.

3. An Updrifter as described in Claim 1 will give greater flexibility for on line ash blending in coal processing applications.

4. An Updrifter as described in Claim 1 will give a more handleable element to the fines inclusion in the industrial and power generation products. When unit is used for coal processing applications.

5. An Updrifter as described in Claim 1 will give a reduction in the loss of saleable material reporting to discards i.e. coal from fines treatment.

The Patent Office

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**Application No:** GB 9601062.4 **Examiner:** Dr. A.J.Rudge
**Claims searched:** 1 **Date of search:** 12 April 1996

## Patents Act 1977
## Search Report under Section 17

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): B2H(H7,H14)

Int Cl (Ed.6): B04C-003/00;B07B-004/00;02;08

Other: ONLINE DATABASES:WPI,CLAIMS,EDOC,WPIL

**Documents considered to be relevant:**

| Category | Identity of document and relevant passage | | Relevant to claims |
|---|---|---|---|
| A | US4834887 | (Broughton) | |
| A | US4265741 | (Chang) | |
| A | US3901799 | (Adkinson) | |

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|---|---|---|---|
| X | Document indicating lack of novelty or inventive step | A | Document indicating technological background and/or state of the art. |
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| & | Member of the same patent family | E | Patent document published on or after, but with priority date earlier than, the filing date of this application. |